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UNFERMENTED FRUIT JUICES

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During recent years the production of fruit juices has very greatly increased. Several factors have been responsible for this rapid development, the most important being improvements in the quality of the finished products and effective advertising.

Because of the increased sale for these products there has arisen an insistent demand for information upon methods of manufacture. It has therefore seemed desirable to publish the available information from all sources (including that derived from our own investigations).

GENERAL PRINCIPLES

Any fruit juice is most attractive when it is first pressed from the fresh fruit; any treatment that may be given it thereafter injures its delicate flavor and aroma more or less, and our most important problem is that of retaining in the finished product as much as possible of the pleasing qualities of the fresh juice. We may improve its appearance by making it clearer, but cannot improve upon the natural flavor.

1. *Preservation.*—Fresh fruit juices soon spoil completely through fermentation or molding, if nothing is done to destroy or prevent the growth of yeasts and molds. These are easily killed by temperatures between 160° F. and 180° F., and if the juice is hermetically sealed before sterilization by heat it will not spoil so long as the container remains sealed against the entrance of living yeast or mold cells. Sterilizing fruit juices at temperatures below 212° F. is commonly termed pasteurization and is the most generally used process of preservation. It must be carried out in such a way that the minimum injury compatible with complete sterilization of the juice shall result. Too high a temperature of pasteurizing or too long a period of heating injures the fresh fruit flavor and will impart a cooked taste.

Juices held in cold storage at 32° F. or above will in time (six months or less) spoil; but if maintained in the frozen condition at temperatures below 32° F. (freezing) will keep indefinitely. The flavor is only slightly impaired by such treatment. This method of preservation remains to be tested commercially, but appears to have great possibilities.

Chemical preservatives were at one time used freely to preserve fruit juices but are now less popular. Sodium benzoate is the most commonly used of these preservatives and is allowed by law if declared on the label. Sulfurous acid is used in special cases to preserve grape juice for short periods but not for permanent preservation.

If sterilized bottles and corks are used, if the juice is filtered perfectly clear, and thus practically freed of molds and yeasts, it is possible, when great care and skill are used, to preserve juices in bottles with heavy pressures of carbon dioxide without use of heat or chemical preservatives. Juices so preserved are superior in flavor to pasteurized juices, but the method has not been entirely satisfactory in practice because of the difficulty in avoiding contamination of the juice with molds and yeasts. This process was patented by Mr. W. Ruef over twenty years ago and his process is therefore now open to the use of the public.

2. *Clearing the Juice.*—In addition to preserving the juice against fermentation and molding, it is desirable to improve the appearance by making it as clear as possible. Filtration is the most common method, by centrifugal force and clarification by finings (clarifying materials) are also used. The latter process consists in adding to the juice some substance such as white of egg or casein which coagulates and settles to the bottom of the container, carrying down the particles of pulp and other solids responsible for the cloudiness of the juice.

3. *Cleanliness.*—The presence of a small amount of moldy or soured fruit will spoil the flavor of a large volume of the product. Only sound, clean fruit should be used and all fruit should be carefully sorted. Only clean press cloths, pumps, sterilizers, filters, and containers can be employed without injury to quality. Cleaning and sterilizing such equipment with hot water and steam is desirable. Press cloths and other equipment should be kept dry when not in use.

EQUIPMENT

Most of the equipment used in fruit juice manufacture has been developed in other industries, notably in wine making, brewing, and vinegar making. The most common forms of such equipment will be described briefly and illustrated. More complete descriptions may be had from dealers and manufacturers.

1. *Sorting Equipment.*—Broad, heavy woven endless cotton belts which carry the fruit to be sorted slowly past the sorters are often used in canneries and evaporators for sorting purposes and may be used to advantage, especially with apples, in sorting fruit for juice manufacture. Belts made of metal cloth similar to ordinary metal door matting are very satisfactory because they may be easily washed and may be fitted with sprays at one end for washing the sorted fruit.

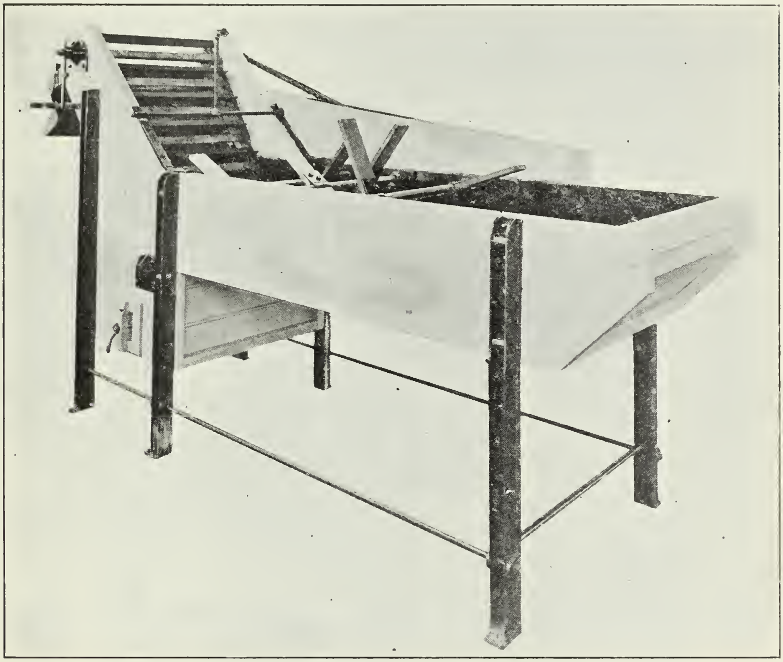

Fig. 1. Fruit or vegetable washer; suitable for washing apples before crushing. (Courtesy of Berger and Carter Company, San Francisco)

2. *Washing Equipment.*—Fruit often arrives at the factory very dusty or soiled from contact with spoiled fruit. It will generally improve the quality of the product in all cases to wash the fruit before crushing. The most effective washing device for fruits that will withstand rough treatment is the rotary tomato washer; others may be washed in the machine shown in figure 1 or under sprays of water.

3. *Crushers.*—The most satisfactory type of crusher for general use is that commonly used for apples under the name of "apple grater." It consists of a cylinder on the surface of which are fixed short knives and in some cases a set of concaves or upright knives against which

the cylinder revolves, or in other styles a corrugated plate, the fruit being grated or crushed between the plate and cylinder. The upright knives or the corrugated plate are fixed to strong springs in order that the crusher will have flexibility and not be broken by pieces of wood or stone which may accidently fall into the crusher.

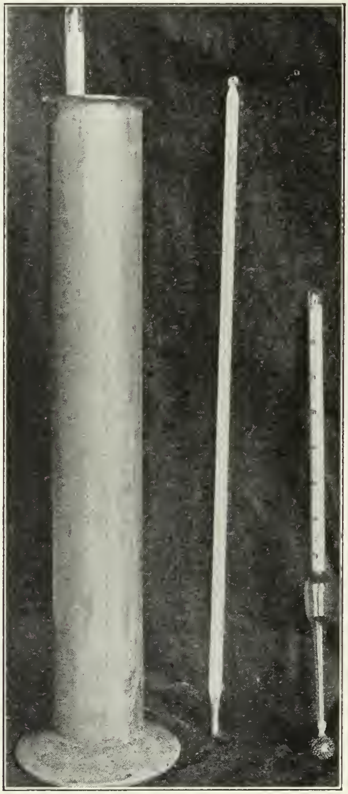

Fig. 2. Balling hydrometer and cylinder for testing sugar content of juice.

For grapes the best crusher is the one formerly in common use for crushing grapes for wine making. It consists of two corrugated or fluted metal rollers which revolve closely together and toward each other, carrying downward between them and crushing the grapes fed into a hopper above. Connected with the crusher is a stemmer consisting of a horizontal metal cylinder with perforated bottom, through which the grapes are forced by revolving paddles. The stems cannot pass through these openings and are thrown out at the end of the crusher. Grapes for red juice making should be stemmed.

For farm use small hand power crushers, usually with a press mounted on the same frame, are available. These are designed either for grapes or apples, but the apple crusher style will find the greatest application, being suited to both apples and soft fruits.

4. *Presses.*—The press known as the "rack and cloth" press will give a higher yield of juice than will the basket press. In the rack

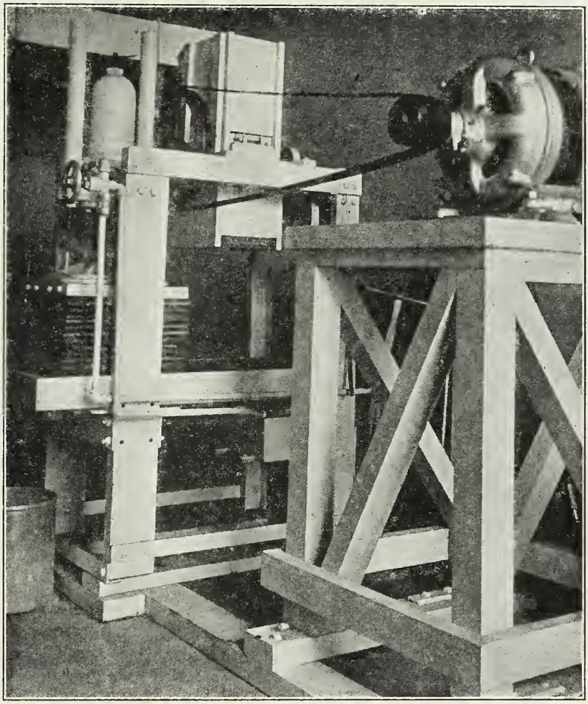

Fig. 3. Fruit crusher and press. Used in Fruit Products Laboratory of University of California.

and cloth press the crushed fruit is built up in layers in heavy press cloths between racks made of wooden slats. Pressure is ordinarily applied by means of an hydraulic pump, although cog gears are often used. It is usually attached to the same frame as the crusher.

In basket presses the cloths and racks are not used. The crushed fruit is held in a strongly reinforced wooden basket of cylindrical shape, which rests on the press floor. The basket is movable. Pressure is applied by a lever and screw in small outfits and by hydraulic pressure in the larger presses.

A very satisfactory home made press can be made of farm equipment arranged as shown in figure 18. It may be used either with racks and cloths or with a basket.

5. *Pasteurizers for Juice in Bulk.*—Most juices before filtering should be heated to coagulate proteins and gums which would otherwise precipitate in the bottle and cause cloudiness. Grape juice is usually sterilized and stored several months to permit separation of cream of tartar before bottling. This sterilization is accomplished upon a large scale by use of some one of the pasteurizers described below.

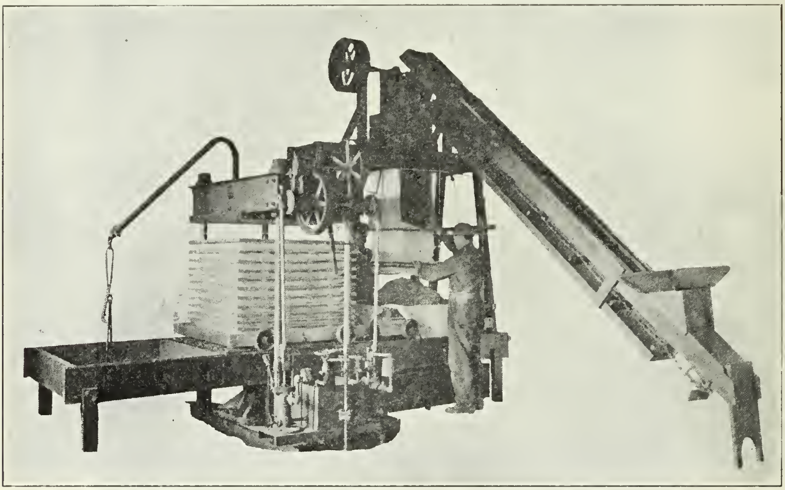

Fig. 4. Large size apple grater and press.
(Courtesy of Hydraulic Press Manufacturing Company)

A very common and effective sterilizer consists of a block tin or aluminum pipe surrounded by a steam jacket. The juice flows through the inner pipe and steam admitted to the jacket heats the juice to any desired temperature. A thermometer at the juice outlet is necessary for control of temperature. The hot juice may be delivered by means of a hose to the final containers in place on shelves or racks.

An objection sometimes made to this pasteurizer is that the juice in contact with the walls of the pasteurizer may be overheated and impart a cooked taste to the juice. This is overcome if the juice pipe is surrounded by hot water instead of steam as indicated in figure 12. This type has been used very successfully in our experiments.

Ordinary large steam jacketed aluminum walled jelly kettles are very commonly used in the eastern grape growing districts of the United States. See figure 11.

Another common form of discontinuous pasteurizer consists of a tank or barrel in which is placed an aluminum steam coil or a tin-coated copper coil. The tank is filled with juice and steam admitted to the coil heats the juice to the pasteurizing temperature. This type is objectionable because of excessive exposure to the air and danger of scorching of the juice in immediate contact with the coils.

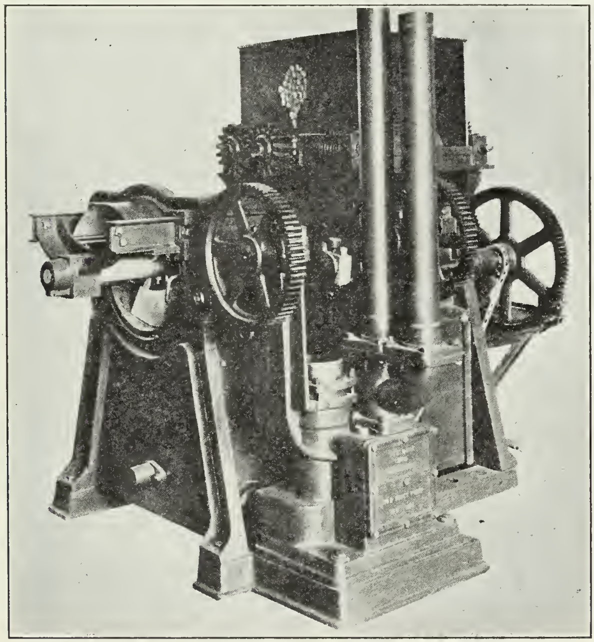

Fig. 5. Large size grape crusher and stemmer.
(Courtesy of E. T. Meakin)

6. *Filters.*—Some fruit juices should be made as clear as possible before bottling. This usually involves filtration.

The simplest filter is the bag filter, which consists of a conical heavy duck or felt bag which is used in the same manner as an ordinary jelly bag. The rate and effectiveness of filtration are increased by the addition of infusorial earth to the juice before filtration, although the flavor of the juice may be affected. Bag filters commonly hold ten gallons of juice at each filling. They are very satisfactory for small scale operations.

For larger scale manufacture of fruit juices some form of wood or cotton pulp filter is generally used. Wood pulp filters vary greatly in appearance and design. Figure 13 illustrates a very effective type. It consists of several thick disks of wood pulp in a tin-lined copper cylinder. The discs of pulp are separated by metal screens and the juice is admitted to the cylinder in such a way that each layer of pulp acts as an independent filter, thus giving a very large aggregate filter-

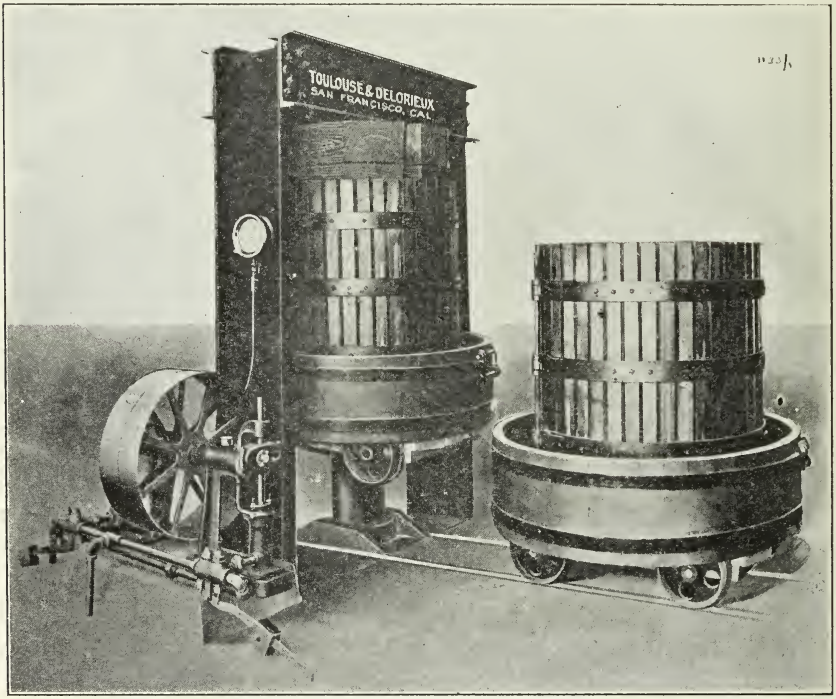

Fig. 6. Basket type of hydraulic press. Suitable for grapes. (Courtesy of E. T. Meakin)

ing surface. The pulp is washed after use by stirring in water by means of a mechanical agitator. It is then pressed into discs and used over again in the filter. A certain amount of cotton fiber is usually mixed with the wood pulp to act as a binder, or cotton fiber is often used to replace wood pulp entirely.

A form of pulp filter known as the "Dutch wood pulp filter" consists of a screen and enclosing cylinder. Pulp is packed upon the screen to act as a filter.

The Seitz filter consists of a very fine tin or silver screen, usually conical in shape, enclosed in a cylinder. The first juice to be passed through the filter is mixed with asbestos fiber of a special grade manufactured for this filter, which forms a filtering surface on the screen.

Filter presses are used in many industries for filtering large volumes of various liquids and have also been used successfully for fruit juices. Filtration is accomplished by forcing the liquid under heavy pressure through cloth or canvas sheets held between metal or wooden plates. "Filter-Cel," a special form of infusorial earth, is

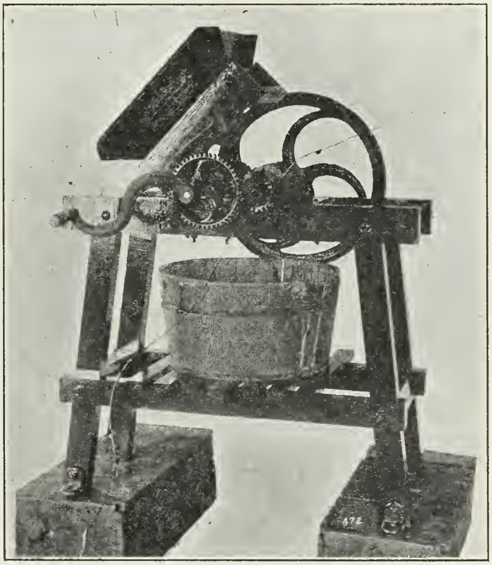

Fig. 7. Hand power fruit crusher.
(Courtesy of Hydraulic Press Manufacturing Company)

often added to the liquid to be filtered to aid filtration. Metal parts in contact with juices should be heavily tinned or silver plated.

7. *Containers*—Grape juice is usually stored several months at a low temperature to allow the excess of cream of tartar to separate and to aid clarification. Some factories use 50-gallon barrels for storage, but 20-gallon or smaller glass carboys (demijohns) are better because glass does not injure the flavor of the juice.

Glass bottles are the usual final packages in which the juices are sold. Two types are in use: those closed with an ordinary crown or soda water bottle cap and those upon which the Goldy caps are used. The Goldy caps may be removed without the use of soda bottle opener.

Both styles of caps are applied by special machines, which fasten the caps to the bottles by pressure. See figures 16 and 17.

Cans may be used for white juices, but the color of red juices often changes to blue or purple in tin or lacquered tin containers.

8. *Bottle Pasteurizers.*—Large glass carboys used for storage of juices are sterilized by means of live steam in an enclosed box into which the carboys may be run on a truck. The empty carboys are sterilized in this way just before they are to be filled with hot juice.

Filled bottles or cans of juice are sterilized by heating them in water to the desired temperature.

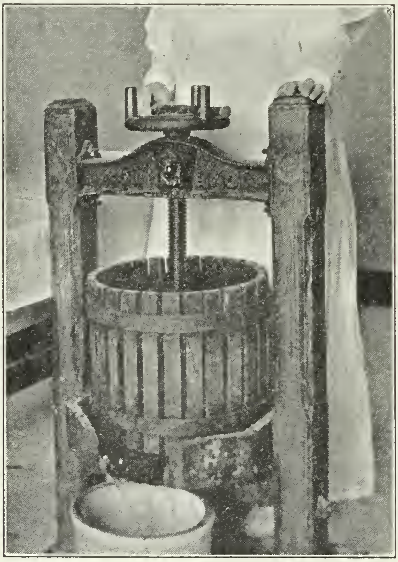

Fig. 8. Small hand power basket press for all varieties of fruit.

The pasteurizer may consist of a shallow metal or wooden vat with perforated false bottom to hold bottles or cans and a perforated steam coil beneath the false bottom.

9. *Steam Supply.*—A steam plant will be necessary except for the very smallest factories. To operate a pasteurizer capable of sterilizing 500 gallons of juice per hour a 25 H.P. boiler should be available; other sizes in proportion to output. Steam is also necessary for sterilizing empty barrels, carboys, pipe lines, press cloths, etc., that come in contact with the juice; but if the boiler is large enough to operate the pasteurizer, it will also furnish enough steam for these miscellaneous purposes. Steam and an abundance of water are very desirable.

10. *Bottle Filling Machines.*—In the production of bottled juices in quantity some form of automatic bottle filler will be needed. Those formerly used in breweries answer the purpose very well. For the small factory a soft half-inch hose and a small hand bottle filling device may be used.

11. *Labeling Machines.*—Bottles or cans may be labeled by special machines much more rapidly and just as neatly as by hand. Such a machine is practically a necessity for large plants, but is not needed in small plants.

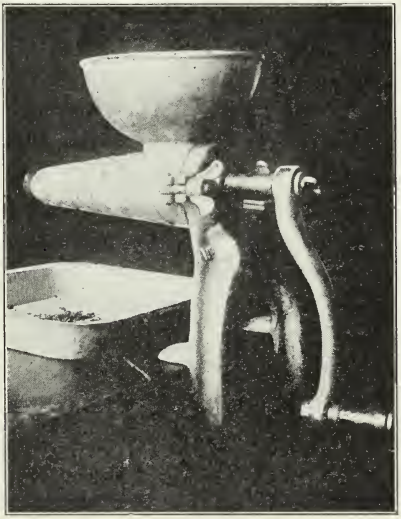

Fig. 9. Small combination crusher and press suitable for household scale production of fruit juices.

12. *Equipment for Home Manufacture of Juices.*—Small combination fruit crushers and presses for use in the kitchen may be bought through any hardware store. (Figure 9, name of manufacturer on request.) Grapes and berries may be crushed with a potato masher or the hands and pressed in a small meat press. An ordinary jelly bag made of muslin or flannel will serve for a filter. A wash boiler fitted with a false bottom may be used as a pasteurizer.

GRAPE JUICE MANUFACTURE

1. *Desirable Qualities of Grape Juice.*—A red juice is commonly preferred, and the more intense the color the better. High acidity, that is, a tart flavor, is necessary in a successful product. Clearness

is desirable but not essential, although a heavy deposit of pulp should never accumulate in the bottled product. Canned juice may be slightly cloudy.

In addition to these qualities the juice must have a distinctive and pleasing flavor. In a popular juice this flavor must be very pronounced. However, it has been demonstrated that grape juice of a fine and delicate flavor may be made from the finer varieties of wine grapes grown in California and that this type of juice is preferred by some consumers.

2. *Varieties of Grapes for Juice.*—At present the most popular juices are those made from the Concord and other closely related eastern (i.e., Labrusca) varieties. In California the Pierce Isabella could be used as a substitute for the Concord, as it combines in a single variety high color, high acid, and a strong "foxy" flavor. It may be grown most successfully in the coast counties.

None of the commonly grown Californian (European) varieties possess in a single variety all of the desired qualities. The Muscat has a strong flavor but is white in color and not very high in acid. When blended with suitable varieties of red wine grape juices a very excellent product, which compares favorably with Concord juice in color, acid, and flavor, may be made. It is believed that such a juice can be made a strong competitor of eastern juices. The better varieties or red wine grapes such as St. Macaire, Barbera, Valdepeñas, and Crabbe's Black Burgundy, give better results than do the commoner varieties, such as Petite Sirah, Zinfandel, Alicante Bouschet, Carignane, and others, but these latter varieties may be used successfully to blend with Muscat juice.

For the production of juices of delicate flavor, which will appeal to connoisseurs of fine wines, varieties such as Semillon, Franken Riesling, or Colombar should be blended with acid varieties, such as Burger or West's White Prolific. There should be a demand for an appreciable quantity of such juices at high prices among the former users of fine wines.

3. *Gathering the Grapes.*—The composition of the finished juice is governed by the time of picking the grapes. Eastern varieties should be gathered at about 17 per cent to 18 per cent Balling as indicated by the Balling "sugar" tester shown in figure 2. This percentage of sugar is easily reached in California, but is difficult to obtain in eastern grape growing regions.

Muscat, Semillon, and other flavor grapes must reach the stage of maturity at which their flavor is well developed. This is 22 per cent to 23 per cent Balling. The acid grapes to blend with the flavor grapes should have a good color but still be very sour; that is, about 17 per cent Balling. With Zinfandel grapes, in order to obtain both acid and color, it will be necessary to gather the first crop at 20 per cent to 22 per cent Balling for color and at the same time enough of the second crop to impart a very tart flavor. Ordinarily the color and acid varieties will have to be gathered several weeks before the flavor varieties have ripened sufficiently.

A test of the acidity of the grapes is important. The finished juice should contain from .9 to 1.1 per cent acid expressed as tartaric acid. This test is simple and can be made with equipment which may be obtained from any chemical supply house. Names of these companies will be furnished upon request.

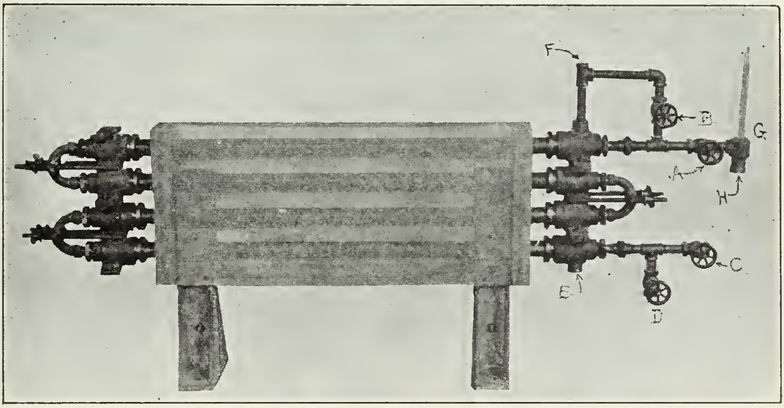

Fig. 10. Steam heated continuous pasteurizer for fruit juices.
A, juice valve; *B*, steam valve; *C*, juice inlet; *D*, to sewer; *E*, to steam trap; *F*, steam inlet; *G*, thermometer; *H*, juice outlet.
(Courtesy of Hydraulic Press Manufacturing Company)

To make the test measure 10 c.c. of the juice by means of a 10 c.c. pipette into a tumbler. Add water to fill the tumber one-quarter full. Add a few drops of phenolphthalein indicator solution. Fill the burette with tenth normal sodium hydroxide solution and read the level of the liquid in the burette. Add the tenth normal sodium hydroxide solution slowly to the juice in the tumbler until one drop finally turns the liquid in the tumbler permanently pink. Read the level of the liquid in the burette again. The difference between the first and second readings represents the amount of solution needed to neutralize the acid of the juice. This figure multiplied by .075 will give the acidity of the juice in per cent. Example: 1st reading, 4.0; 2d reading, 15.5. Difference, 11.5. Acidity $= 11.5 \times .075 = .86\%$.

The grapes should be crushed as soon after picking as possible to forestall molding or souring. Only clean lug boxes should be used.

4. *Crushing and Stemming.*—The grapes must be thoroughly crushed. White grapes should not be stemmed because the stems aid in pressing. Red wine grapes should be stemmed for the reason that heating the juice later to extract the color will leach from the stems an astringent principle of disagreeable flavor.

5. *Pressing.*—White grapes must be as completely pressed as possible without heating. The color of grapes used for red juice is held in the skins and this must be extracted by heat. Therefore, such grapes are not finally pressed until the juice has been heated upon the skins.

6. *Extraction of Color.*—There are two methods in use for extraction of color. The most commonly used process consists of heating the mixed skins and juice in a large double jacketed steam-heated aluminum kettle to 160° F. for a few minutes. The grapes are then pressed hot at once.

The other method consists in first lightly pressing the crushed stemmed grapes to obtain one-half or two-thirds of the juice. The pomace (pressed skins and seeds) is thrown into a clean wooden vat. The juice is heated in one of the bulk pasteurizers previously described, to about 140° F., is then mixed with the pomace and allowed to stand until sufficient color is extracted. This will be four to eight hours. The skins and juice should be frequently stirred to hasten color extraction. The grapes may then be pressed. Heating destroys the slimy character of the crushed grapes and thus facilitates pressing.

The second method described above for color extraction has given the better results in our experiments because it avoids danger of overheating the skins or juice. High temperatures (150° F. to 180° F.) of mixed juice and skins cause the juice to develop a harsh flavor, probably because of materials extracted from the seeds. We have found that temperatures of mixed skins and juice of 130° F. to 110° F. give the best flavor and at the same time permit of satisfactory extraction of color.

7. *First Pasteurizing.*—The juice must be heated to coagulate proteins, which would cause the juice to be cloudy if bottled direct from the press. If cream of tartar crystallization in the bottled product is to be prevented, the juice must be stored several months to permit this to separate before final bottling; and in order that the juice

will not ferment during this storage it must be sterilized in or into sealed containers.

In some grape juice factories the juice is heated to 175° F. to 190° F. in aluminum kettles and then transferred at this temperature to glass carboys that are still hot from having been sterilized in steam. Any one of the continuous pasteurizers previously described may also be used. The carboys in either case are filled to overflowing and are then sealed with corks sterilized in scalding hot melted paraffin. The tops of the carboys and corks are then sealed with paraffin or wax.

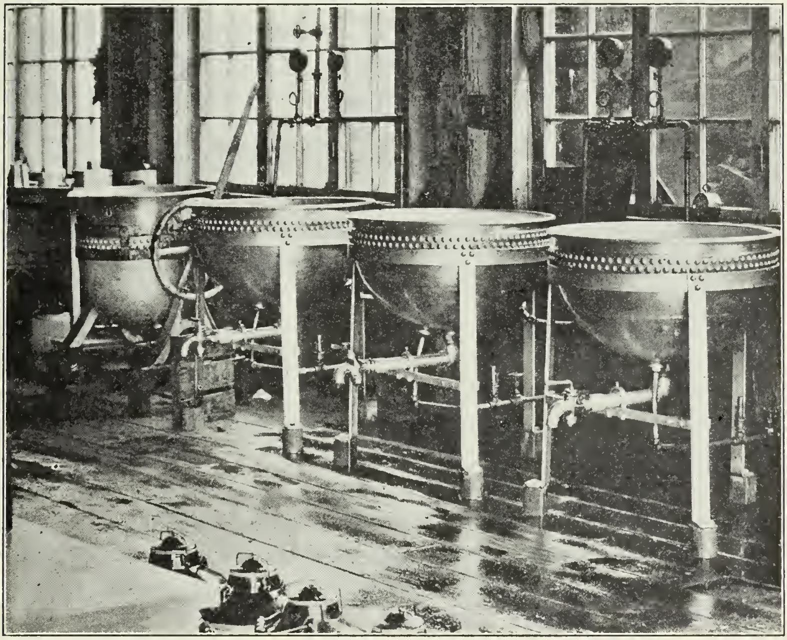

Fig. 11. Battery of steam jacketed aluminum kettles used for fruit juices and jellies. (Courtesy of Wearever Aluminum Company)

In California 25- or 50-gallon barrels are often used instead of glass containers. The barrels must be sound and sweet. New barrels should first be treated with hot soda ash solution and several days' leaching with hot water to remove the oak flavor. Just before they are to be filled, the barrels are thoroughly steamed and the hot juice is filled into them. They are bunged tightly with ordinary shipping bungs and muslin. Both the bungs and muslin must be sterilized several minutes in boiling water before use. After filling and bunging, the barrels should be rolled slightly on their sides to permit the hot juice to sterilize the bungs. The barrels should be thoroughly painted with melted paraffin or shellac to render the wood airtight. Barrels have been proved by repeated tests to be very much inferior to glass containers for storage because they injure the flavor of the juice and permit browning of the color through oxidation. Their use is *not* recommended if large glass carboys are obtainable.

8. *Storage.*—Separation of cream of tartar is greatly hastened by low temperatures. Therefore large factories use refrigeration during storage. Where refrigeration is not available the same results are obtained by simply storing the juice through the winter until February or March in a room which reaches outside winter temperatures. Our tests show that storage until February 15th is sufficient. By leaving the doors open on cold nights and closed during the day, the desired temperatures will be readily attained.

The containers should be on shelves or racks well above the floor in order that the juice may be drawn off after storage.

9. *Drawing Off after Storage.*—The settled juice after storage must be drawn off the sediment. This is most conveniently done by syphoning. A half-inch soft rubber hose attached to a short gooseneck of three-eighths inch tinned copper or brass pipe makes a convenient syphon. The gooseneck rests on the bottom of the carboy or tank, the inlet being slightly above the level of the sediment in the container. Thus the juice is drawn downward into the syphon and the sediment is not disturbed.

The juice may be drawn off by means of a plain hose without use of gooseneck if care is used. A piece of half-inch bent glass tubing about three feet long and attached to a hose make a convenient racking syphon.

10. *Filtration.*—Some Eastern grape juice manufacturers merely strain the juice from the storage containers through cloth. A much clearer product may be obtained by filtration by means of one of the filters previously described. If the racking (drawing off) of the juice after storage has been well done, filtration is rapid.

11. *Clarification.*—Some juices do not settle satisfactorily in storage and are difficult to filter. These may be made clear by the addition of a suitable clarifying agent, followed by pasteurization and settling. The clarifying agent may be added to the juice before the first pasteurization, but if this is to be done the juice should be permitted to settle ten hours if red and twenty-four hours if white, after pressing and before the clarifying material is added, in order to remove coarse particles of pulp, etc. The clarifying agent is most commonly added,

however, after the juice has remained in storage. This practice makes it necessary to clarify only those lots of juice which have failed to settle satisfactorily during storage. The clarifying agents used in factories and also found most suitable in our experiments are egg albumen, casein, and Spanish clay.

Dried egg albumen may be purchased in granular form. It is first ground and then dissolved by soaking in water at the rate of three ounces of the egg albumen per gallon of water. About four gallons of this solution are added to each 100 gallons of juice; although the amount needed will vary with the juice. The two are mixed thoroughly and heated to 175° F. to 180° F. in most factories, and the juice is then transferred hot to sterilized barrels or carboys and sealed to permit settling. If successful, the juice may be drawn off perfectly clear. The objection to egg albumen is its tendency to produce a deposit in the juice after clarification and bottling.

Casein is less likely to give a deposit after bottling but causes considerable bleaching of the color. It is purchased in fine granular form. It is soluble only in alkaline solutions such as dilute spirits of ammonia or soda ash or soda lye, etc. A very excellent method of preparing the solution is to mix with each three ounces of casein used about three fluid ounces of strong ammonia water; allow to stand about one-half an hour and then add two quarts of water. Boil with stirring until practically all odor of ammonia disappears. Dilute to one gallon with water. Use two to three gallons of this solution to each one hundred gallons of juice. The treatment thereafter is the same as for egg albumen, although casein settles more rapidly and completely than does egg albumen and the juice may usually be drawn from the sediment and filtered for bottling within twenty-four to forty-eight hours after clarification. The acid of the juice is the agent which causes the casein to separate.

Spanish clay is a brown clay high in organic matter, imported from Spain. It is at present difficult to obtain. One pound of the clay is mixed with one gallon of water and the mixture agitated in a barrel arranged upon a shaft so that it may be rotated end for end for several hours by means of a pulley and belt; a fine-grained thin mud free from coarse lumps must be obtained. Four to eight gallons of this "solution" is used per hundred gallons of juice. It may be used in combination with casein or egg albumen solutions to advantage. It settles very rapidly, usually in less than twenty-four hours; therefore it is not necessary to pasteurize juice treated with Spanish clay, if the juice has been previously heated to coagulate the proteins of the juice. Spanish clay is, however, open to the objection that it may occasionally cause a deposit in the juice after bottling.

Juices that are clarified as noted above must also usually be filtered before bottling to remove floating particles of the clarifying materials, but filtration will be much more rapid and the filtered juice brighter than is the case where clarifiers are not used.

Juice from eastern varieties of grapes cannot be successfully clarified because of the high pectin and gum content of such grapes. Muscat juice is also difficult to clarify.

In most cases filtration alone will accomplish the desired results and is less troublesome than clarification.

12. *Bottling.*—After removal of cream of tartar and after the juice is made clear as described above, it is filled into bottles. Quart bottles must be filled only to within about one and a half inches of the top, this space being necessary for expansion of the juice during pasteurizing. An automatic bottle filling machine will hasten this work. The bottles must be thoroughly washed before use and should, if facilities permit, be sterilized in live steam a short time before filling, but must be cool at time of filling.

The caps used in sealing the bottles should be placed in live steam or boiling water for a period of about one minute just before use. This will destroy mold spores on and in the cork of the bottle cap. Practically all spoiling of juice in bottles by mold growth is caused by the resistant mold spores to be found on all such non-sterilized caps. The cork is a poor conductor of heat and thus protects the spores during sterilization of the juice; hence the need of sterilizing the corks or caps before use.

13. *Pasteurizing Bottled Juice.*—The bottled juice must be sterilized at once by heat to prevent spoiling. A temperature of 165° F. to 170° F. for thirty minutes in the bottles is necessary to insure complete sterilization of juice which is not carbonated. The bottles are placed in a horizontal position on the false bottom of the sterilizer in order that the juice shall be in contact with the cap and thus make certain that the inner cork disc of the cap reaches the sterilizing temperature of the juice. If the bottle is in an upright position the air space in the top of the bottle acts as an insulator and prevents the cap being thoroughly heated. The bottles are covered with water and the water heated by steam or direct heat to 170° F. to 172° F. and kept at this temperature thirty minutes. Tests have shown that there will be about 2° F. difference between the temperatures of the bottled juice and the surrounding water.

The water is then drawn from the pasteurizer and the bottles placed in a room free from violent drafts of cool air; or may, if desired, be allowed to cool in the pasteurizer. The latter practice avoids the necessity of handling the hot bottles.

14. *Storing Bottled Juice.*—The finished juice should be held for at least four weeks at a warm room temperature to determine whether it will remain clear and free from mold.

15. *Bottling Juice without Removal of Cream of Tartar.*—The juice may be bottled twenty-four hours after crushing of the grapes if bottled without storage to remove cream of tartar. The juice may

Fig. 12. Continuous water heated aluminum coil used at University Farm for pasteurizing grape juice into barrels. At left, complete pasteurizer. At right, coil. The juice to be sterilized flows through the coil. Designed by F. T. Bioletti.

be made clear by processes already described; may then be bottled and pasteurized, the total length of time from vine to bottle not exceeding three days. Such juice will, however, develop a crystalline deposit of cream of tartar. This does not affect the flavor and injures the juice in no way, except in appearance.. The deposit is small, but might cause the consumer to doubt the purity of the juice unless the label were designed to explain the presence and character of the crystals.

This method reduces the expense of manufacture and the investment in equipment. Juice so made is handled fewer times than that made by the usual methods and is therefore richer in flavor and of better color. It is a method worthy of commercial trial.

16. *Carbonating Juice before Bottling.*—Carbonated juices are always more popular than still juices for the same reason that sharp or sparkling cider is preferred to the juice fresh from the apple. Besides increasing the palatability of the juice, the carbonation greatly reduces the temperature necessary for sterilization. Juices that are lightly carbonated may be sterilized at 150° F. or less.

A carbonated juice should be clear and free from sediment to be attractive.

Carbonating consists in impregnating the juice with carbonic acid gas and in bottling under a pressure of the same gas. Carbon dioxide, that is, carbonic acid gas, is sold in the liquefied state in steel cylinders.

The solubility of the gas in the juice is greatly increased by low temperatures. A convenient and effective system of carbonating consists in chilling the juice to near freezing and in agitating the chilled juice in a strong, sealed container into which the gas is admitted under pressure. Fair results can be obtained by carbonizing the chilled juice in open containers. Pressure gauges, safety valves, and automatic pressure controls should be used to avoid accidents from bursting pressures. Fifteen to twenty pounds' pressure per square inch will be sufficient. The juice after carbonation is filled directly into bottles and capped at once.

Another system of carbonating consists in impregnating the juice by aspiration; that is, the chilled juice is passed through a column into which the carbonic acid gas is admitted. The juice flows directly into the bottles under pressure.

A convenient and simple method for small scale operations is to place the juice in a heavy beer keg; to connect a cylinder of gas to a carbonating inlet which may be purchased for such barrels; to admit gas up to fifteen pounds' pressure and agitate and roll the barrel for about fifteen minutes, admitting gas frequently to maintain the pressure at fifteen pounds. If the juice is cool, it may then be drawn off and bottled, but it will be necessary to admit gas to the barrel occasionally during filling of the bottles to maintain a constant pressure.

The bottles of carbonated juice are sealed and sterilized at 150° F. for thirty minutes. *Do not handle the bottles while they are still hot because they will be under a dangerous pressure due to expansion from heat.*

17. *Canning Grape Juice.*—The time and expense of manufacture are greatly reduced if the juice is canned. Red juice tends to become blue or purple in color after canning, unless heavily lacquered cans are

used. For this reason white juice has been canned more satisfactorily than red juice.

The canning of white juice may well become an important line of endeavor for fruit canneries. A process suitable for commercial use is as follows:

The grapes are crushed and pressed. The juice may be heated to 170° F. and allowed to stand over night to cool and settle, or may be passed at once through cooling coils after heating. The cool juice may be filtered roughly and filled into cans. A can syruping machine would make an excellent filling device. The filled cans may be passed through a cannery exhaust box slowly and heated therein to 175° F. The cans of hot juice may be capped at once and turned upside down to cool. Lacquered cans should be used. Red juice may be canned in a similar manner.

A modified process consists in warming the filtered juice to about 140° F., filling into cans, sealing, and sterilizing in water at 175° F. for twenty-five minutes.

Another process in use for apple juice consists in heating the filtered juice to 175° F. and filling into cans at this temperature and sealing without further treatment. Red grape juice has been canned experimentally by heating the crushed grapes to 160° F., pressing, filtering, and canning as directed above.

The canned juice posseses as much flavor as the bottled product, but will be slightly cloudy. It may be produced very cheaply and it should be possible to sell it for 30c or less per quart can at retail if grapes may be had at $40 per ton or less. At $40 per ton for grapes the raw material for one quart of juice costs 6¼c. The can and label will cost about 4c, the cost of manufacture not more than 2c, and the case about 2c per quart. This gives a total cost of about 14¼c per quart.

18. *Pasteurized Juice in Barrels for Export.*—Either red or white juice may be pasteurized into sterilized barrels as described under "Bulk pasteurization" at 175° F. The barrels must be bunged at once with sterilized bungs and the outside of the barrels coated with paraffin, shellac or other impervious coating to prevent infection. Such juice may be exported to foreign countries for various purposes or sold in the United States for use in large soft drink dispensaries or at picnics, etc., where a cheap juice of good quality is desired. The possibilities of the marketing of juice in this form have been tested by a large company during the past season.

19. *Preservation of Juice with Sulfurous Acid.*—If grape juice is stored in a cool place (60° F.–65° F. or less), it may be kept for at least one year by the addition of one-tenth of one per cent of sulfurous acid, which corresponds to 12½ ounces of sulfurous acid or about 1¾ gallons of commercial six per cent sulfurous acid solution per 100 gallons of juice. Juice stored at higher temperatures requires proportionally larger amounts of the sulfurous acid to prevent fermentation.

Juice preserved in this way cannot be used for drinking purposes until the sulfurous acid is removed. This can be done by heating the juice to 160° F. and at the same time passing a violent stream of air through it for about an hour and a half. This removes enough of the sulfurous acid to permit the juice to be used for drinking purposes, syrup making, or vinegar manufacture; or the juice after removal of the preservative may be sterilized in barrels. J. H. Wheeler of St. Helena preserved and successfully treated 75,000 gallons of juice in this way during the past season.

This method of preservation makes it possible to utilize the storage tanks of wineries to good advantage and makes it possible for a grape syrup factory to have juice on hand throughout the year at little expense.

Juice preserved with sulfurous acid should not be allowed to come in contact with iron or copper; only aluminum or tin (preferably aluminum) or glass should be used. A wooden vat and aluminum steam coil may be used to heat the juice during removal of the preservative; or a large glass-lined steam jacketed vat of the type used for concentrating tomato products is excellent. An air compressor of rather large capacity is also necessary. This should be connected to an aluminum pipe leading to the bottom of the heating vessel, or a piece of steam hose may be used to deliver the air.

Red juice when preserved with sulfurous acid becomes almost white in color, but when the sulfurous acid is removed by aeration practically all of the color returns.

It must be stated, however, that aeration does not remove all of the sulfurous acid and if such juice is offered for sale it must bear the statement that it contains sulfurous acid.

20. *Home Methods of Grape Juice Making.*—A red juice is more satisfactorily made in the kitchen than a white juice. The grapes should not be too ripe but should be still rather tart when picked. A mixture of Muscat and some red wine grapes gives a very pleasing juice.

Crush the grapes in a small household size crusher or merely crush them with the hands into an agateware, tin, or aluminum kettle.

Heat slowly with stirring to 150° F.; a dairy thermometer is useful for testing the temperature. Set aside for about two hours. Place in a jelly bag or in a heavy cloth in a small press. Allow to drain into a pan and press the skins and pulp.

Strain through a cloth or felt bag. Fill into clean scalded bottles. Cork bottles with corks that have been boiled five minutes in water. Tie the corks down with string. Crown finish bottles, crown caps and a small hand-power capping machine may be used. See figure 16, illustrating this capper. Place the bottles horizontally on a false bottom in a wash boiler or large kettle. Fill the vessel with water and heat the water to 175° F. for thirty minutes. Remove bottles and seal corks with melted paraffine.

The strained juice prepared as directed above may be heated to 180° F. and poured into hot, scalded Mason or glass top jars. Scalded rubbers and caps are then put in place, the jars sealed and turned upside down to cool. This method is simple and effective. *Never heat grape juice to the boiling point.*

21. *Costs and Returns on Grape Juice.*—Judging from the results of our experiments at the University Farm it would be possible to erect a small grape juice plant such as the University possesses for about $1000, exclusive of barrels, bottles, or other juice containers. This plant will dispose of about five tons of grapes per day or about one hundred tons in a season of twenty days; or would produce 15,000 to 20,000 gallons of juice per season. It consists of a shed, a small continuous pasteurizer made of 50 feet of five-eighths inch aluminum pipe coiled inside a 50-gallon barrel, a 3 H.P. boiler (5 H.P. is better), a cement vat 5 feet long by 2½ feet wide by 2 feet deep with steam coil for pasteurizing bottled juice, a small asbestos Seitz filter, a foot power Crown bottle capper, a hand power grape crusher, medium size hand power screw basket press, and miscellaneous utensils such as fiber tubs, pails, dippers, hose, etc. To this must be added glass carboys for 15,000 gallons of juice, 60,000 quart bottles or their equivalent in other sizes, caps, labels, and shipping boxes. Our estimated cost is as follows:

ESTIMATED COST PER QUART BOTTLE

Grapes at $40 per ton and yield of 600 quarts per ton	$ .0625
Bottle at 4½c.	.0450
Caps at 30c per gross	.0020
Labels at $10 per M	.0100
Cost of handling at 16c per gallon	.0400
Cost of packing for shipment	.0300
Total	$ .1895

Total cost per quart, about 19c, allowing no charge for interest on investment or depreciation. It should be possible to sell grape juice retail at 40c per quart at a good profit for all concerned. It now sells at 75c to 90c per quart retail.

Canned juice, it is believed, could be produced for less than 15c per quart can and retailed at 30c or less per quart. Apple juice has retailed at 15c per quart in cans.

UNFERMENTED APPLE JUICE

The manufacture of apple juice has become an important industry in the Pacific Northwest, where several breweries have been successful in producing a high class unfermented cider. Several very successful factories of moderate size exist in California.

Carbonated cider is most in demand and must be brilliantly clear.

The general principles are similar to those used in making grape juice. Apple juice is more easily injured in flavor by heat than is grape juice, and therefore requires greater care.

1. *Varieties of Apples.*—Apples of sprightly to acid flavor are best provided they are ripe and possess a full apple flavor. Of the commercially grown varieties of California, the Yellow Newtown has been found satisfactory. The Bellflower is of poor flavor. The Gravenstein is of fair quality for juice but not so good as the Newtown. Northern Spy, Winesap, and other varieties of sprightly flavor are excellent, but scarce. Varieties of very low acid, such as the Tolman Sweet, are of little value and produce juices which are difficult to sterilize. Varieties also which may have sufficient acid but which are of poor flavor are not successful. To this class would belong the Bellflower and Ben Davis.

The apples should be mature enough to possess their full flavor, but should not be over-ripe, because of the decrease in acidity after maturity is reached and because juice from over-ripe fruit is "gummy" and very difficult to filter.

Only clean sound fruit should be used. This usually means that the fruit should be carefully sorted and washed before crushing. See illustration of fruit washer (figure 1).

2. *Crushing and Pressing.*—Apple tissue is firm and tough and the cells possess heavy walls. Consequently crushing must be thorough and pressing severe to obtain a high yield of juice. Crushing too finely, however, causes the pulp to be too soft to press without danger of breaking the press cloths. Pieces one-fourth to one-half inch and

one-eighth to one-fourth inch in diameter are satisfactory. The crusher can be set to grind to any desired degree of fineness.

The crushed fruit is placed in heavy coarse-weave cloths and the fruit is enclosed by folding the cloth. Each cloth of fruit is placed between racks made of hardwood slats. Pressure is applied usually by a hydraulic pump. A pressure of at least 500 pounds per square inch is necessary for the best results. A ton of apples should yield 160 gallons of juice if well pressed. The pomace, that is, the press cake, will yield more juice if broken and pressed a second time, but probably may best be used for by-products, especially vinegar.

3. *Clearing the Juice.*—A common method of clearing the juice consists in heating to precipitate proteins and gums, cooling the heated juice and filtering until clear. Methods of filtering described for grape juice can be used for apple juice. Two or more filtrations are usually necessary. If the juice is to be carbonated before bottling it needs to be heated to 150° F. to 155° F. only; but if to be bottled without carbonating it must be heated to 165° F. to 170° F. In other words, the juice is heated before filtration to a temperature equal to or greater than that to be used in sterilizing the juice in the final bottles, because if it is heated to a lower temperature before filtration the higher temperature during final pasteurizing may cause the juice to become cloudy through further precipitation of protein. This principle is very important and holds for other fruits. Some factories filter the fresh unpasteurized unheated juice and bottle without the preliminary pasteurizing noted above.

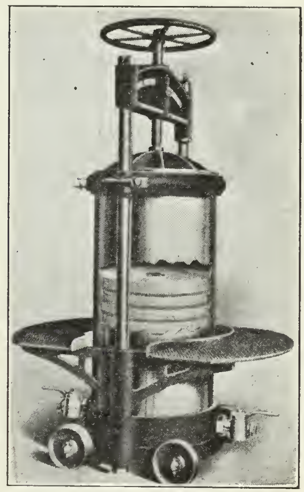

Fig. 13. Wood pulp fruit juice filter.
(Courtesy of Karl Kieffer Company)

Aluminum, tin, glass, silver and monel metal surfaces may be used in contact with hot apple juice with safety. Most other metals are acted upon by the acid of the juice.

4. *Carbonating Apple Juice.*—The methods described for carbonating grape juice are also suitable for apple juice.

If carried out at room temperature the juice should be carbonated to about 15 pounds' pressure. If the juice is first chilled to about 33° F. to 36° F. it will absorb the gas more readily and carbonating to 5 pounds' pressure in a clean barrel will be sufficient; or merely passing the gas through the cold juice will cause it to absorb enough to impart a sharp flavor to the bottled juice, but this method is wasteful of gas.

Apple juice is greatly improved by carbonating and all such juice for sale in bottles should be so treated.

5. *Sterilizing.*—Carbonated juice may be sterilized at 150° F. for thirty minutes. If the juice has not been carbonated it should be heated to 170° F. for thirty minutes. Carbonating reduces the temperature of sterilization because it checks the development of mold.

6. *Spoiling of Apple Juice by Mold.*—Bottle caps are the usual source of infection. Caps are readily sterilized before use by immersing them in boiling water for one minute. This sterilization will greatly reduce loss of juice from mold growth. Bottles should also be sterilized in steam or hot water before use to further reduce danger of mold infection.

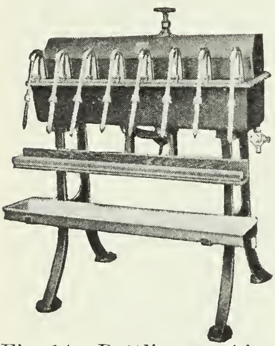

Fig. 14. Bottling machine for fruit juices. (Courtesy of U.S. Bottlers' Machinery Company)

7. *Canned Apple Juice.*—Apple juice retains its flavor well in cans and this method offers the cheapest way of placing the juice on the market in small containers in sterilized form.

Canned juice need not be perfectly clear, but should not show a heavy deposit in the can.

The following method has proved very successful in our investigational work:

The fruit is crushed and pressed. The juice is then filtered through felt filter bags or heavy duck bags to remove particles of pulp. It is then heated to 150° F. and transferred while still hot to enamel-lined sanitary open-top cans and sealed. The cans should be filled completely in order that as little air as possible shall be left in the can; air space in the sealed can causes rapid corrosion of the tin. The sealed cans are placed in a tank of water which is heated to 170° F. for thirty minutes.

Another method in use on a commercial scale is the following: The fresh juice from the press is strained through several layers of cheese cloth; is then heated to 180° F. and run directly into cans which are filled level full. The cans are sealed immediately and no further heating is given. Usually such juice is not so clear as that made by the first process but is of good flavor.

LOGANBERRY JUICE

Loganberry juice has become very popular during the past few years and is now produced upon a large industrial scale in Oregon, making the growing of this fruit very profitable. The development of loganberry juice manufacture is largely due to the work of Professor C. I. Lewis, formerly of the Oregon Agricultural College. The juice is of deep red color, very rich flavor, and high acidity. Thoroughly ripe fruit gives the best juice; that from under-ripe berries being light in color, excessively tart, and astringent in flavor.

1. *Extraction of Juice.*—The juice is best extracted by a combination of crushing, heating, and pressing.

The berries may be crushed in a grape crusher, but wooden or tinned rollers should be used because the acid of the juice attacks iron. The crushed fruit should be heated in tin-lined or glass-lined kettles, with constant stirring, to about 170° F. and pressed at once. Aluminum is rapidly attacked by this juice. Long continued heating extracts tannin and disagreeable flavors from the seeds. The rack and cloth type of apple press should be used for pressing.

2. *Clearing the Juice.*—The juice should be cooled after pressing and before filtration. Because the juice is rich in pectins and gums it is difficult to filter. Several filtrations through wood pulp or asbestos are usually necessary to render the juice bright. Filtration is assisted by the addition of "Filter-Cel." The flavor of the filtrate, however, is slightly impaired by use of too large amounts of this material.

Clarification may also be accomplished as described for grape juice; that is, by sterilizing the juice into glass carboys, allowing it to settle several weeks, drawing off from the sediment, and filtering or clearing by Spanish clay.

3. *Preparing Filtered Juice for Bottling.*—The filtered juice is bottled in three forms: (1) natural juice undiluted and unsweetened, (2) diluted, sweetened, and (3) sweetened but undiluted. The sweetened undiluted juice is the best. Sugar helps to retain the fresh berry flavor and prevents the development of a bitter, astringent flavor noticeable in unsweetened juices after several months' storage. The amount of sugar added is enough to increase the Balling degree of the juice to about 45 per cent, which is approximately 3½ pounds of sugar per gallon of juice. Sweetened loganberry juice is diluted with about two volumes of water (preferably carbonated) when served.

4. *Bottling and Sterilizing.*—The bottles are filled with the cold juice and capped with caps sterilized one minute in boiling water. The juice may be sterilized by heating in water to 170° F. for thirty minutes. Carbonating before bottling reduces the temperature of sterilizing and improves the quality of the juice.

Breweries have been very successful in converting their plants into loganberry juice factories.

The process of manufacture is very simple; little equipment is needed and the quality of the product is high. Its manufacture should therefore prove a profitable undertaking for the grower or growers' organizations.

POMEGRANATE JUICE

When properly made, pomegranate juice is a brilliant purplish red in color and perfectly clear; its flavor is pleasing and it blends well with other fruit juices, besides making a very pleasant beverage of itself when diluted and sweetened. Ordinarily it will be too tart in flavor and the flavor is not retained very satisfactorily unless the juice is sweetened before bottling.

1. *Extraction of Juice.*—The "rag" and peel of the pomegranate contains so much tannin that juice from these portions of the fruit is so "puckery" that it is undrinkable. The desirable juice is in the arals or "kernels.' The problem is to separate these from the peel and "rag."

In our laboratory experiments the kernels were readily separated from the rest of the fruit by passing the fruit through a modified tomato pulper. The outfit used consisted of a horizontal cylinder about three feet long and twenty inches in diameter. The bottom half of this cylinder consisted of a metal screen with three-eighths inch openings; the upper half of this cylinder was of wood. Two wooden paddles were attached to a shaft passing through the cylinder lengthwise. The shaft was revolved at about 400 R.P.M. by means of a 1 H.P. motor. The pomegranates were fed in at one end of the cylinder. The rapidly revolving paddles shattered the fruit by impact and the kernels freed thereby fell through the screen into a receptacle. The rag and peel were thrown out through a hole in the opposite end of the cylinder. It was soon found that iron could not be used in contact with the fruit or juice. Tin, aluminum, Monel metal, or silver may be used. Iron causes the juice to turn black in color and destroys the flavor.

The kernels obtained as noted above were crushed lightly in a tin-lined crusher and were pressed between racks and cloths in a hydraulic cider press. Yields of about ninety to one hundred gallons per ton were obtained.

2. *Clearing the Juice.*—It was found that the juice could be easily clarified by heating, settling, and filtration. The freshly pressed juice was heated to 165° F. and allowed to cool and settle for twenty-four hours. The settled juice was racked from the sediment and was found to filter very quickly. Probably the high tannin content of the juice favors this natural clarification.

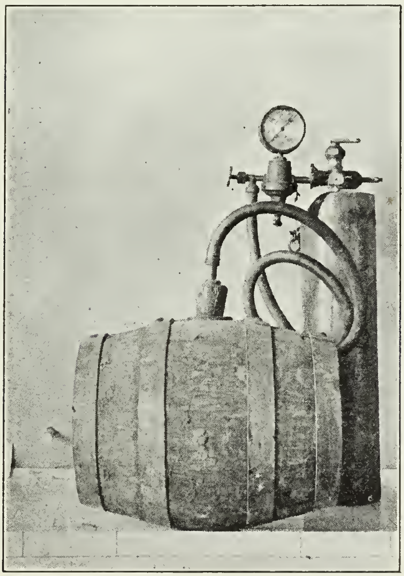

Fig. 15. Simple device for carbonating fruit juices for small scale production.

3. *Addition of Sugar and Sterilizing.*—If the juice is very tart, sugar should be added to increase the Balling degree to about 35° to 40° Balling. If the fruit is very ripe, sugar addition to increase the juice to 30° Balling will be sufficient. By tests made upon measured samples the proper amount of sugar can be quickly determined.

Sweet red grape juice from thoroughly ripe red wine grapes and made as described under ''Grape Juice'' in this publication may be added to pomegranate juice with pleasing results. The blend is less harsh than the straight pomegranate juice and has much more character than plain red juice from wine grapes. Dr. E. M. Chace of the United States Department of Agriculture Citrus By-products Laboratory of Los Angeles has made a number of pleasing combinations of pomegranate juice with other juices, especially grape fruit juice.

Bottling, capping, and sterilizing at 165° F. for thirty minutes are carried out as described for grape juice.

CITRUS FRUIT JUICES

1. *Orange Juice.*—No satisfactory orange juice other than that sold fresh from the fruit has yet appeared upon the market. Many companies have failed in attempts to produce orange juice upon a com-

Fig. 16. Small hand power bottle capper.

mercial scale. Such products as "orangeade," etc., are not orange juice but are preparations usually made up of citric acid, orange oil, sugar, and artificial coloring matter, with in some cases a very small amount of orange juice added.

Orange juice does not retain its fresh flavor in the bottle, but tends in several weeks' time to develop a "stale" and disagreeable taste. On this account no one is advised to attempt to produce a "straight" orange juice commercially until processes superior to those already known are discovered. Small amounts for home use may be put up if desired. In this case, cut the oranges in half, extract the juice on glass orange juice cones to avoid getting oil from the skins into the juice; or the fruit may be peeled, crushed, and pressed. Leave the yellow pulp in the juice because it adds flavor. Bottle and pasteurize thirty minutes at 165° F. Such juice will be drinkable, but not of high enough quality for large scale production.

2. *Orange-Lemon Juice.*—Sugar greatly decreases the tendency for orange juice to become "stale." We have made repeatedly a juice made up of a mixture of orange juice, lemon juice and sugar, and found this product very palatable even after one year's storage.

The fruit was peeled in a small vegetable grating or peeling machine. It was then washed to remove adhering oil and was crushed and pressed in an apple press. The juices were mixed in the proportion of one part lemon juice to four parts of orange juice and sugar was added to increase the Balling degree to 40°; about six pounds of sugar per gallon of juice. The fresh, cloudy, unfiltered juices were found much superior in flavor to the clarified or filtered juices. The sweetened juice was bottled and pasteurized at 165° F. for thirty minutes. When it is to be served it is diluted with about twice its volume of water, carbonated water preferred.

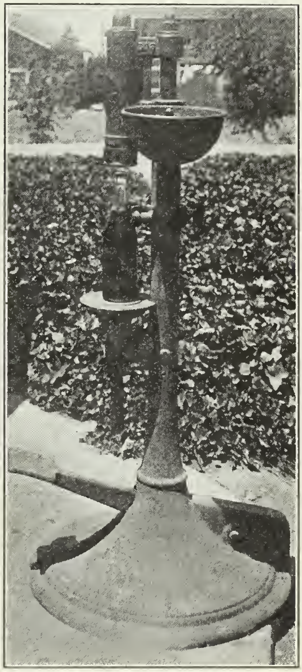

Fig. 17. Foot power bottle capping machine suitable for small factories.

It is believed that this product possesses sufficient merit for commercial purposes.

3. *Lemon Juice.*—This juice is produced in several factories in California. Like orange juice it also develops a "stale" flavor after bottling, but is still suitable for many purposes. The oil from the skins should be excluded from the juice, either by peeling the fruit before pressing or by extracting the juice by means of rapidly revolving aluminum or bronze cones against which the halved fruit is held. It should be strained through cloth to remove gross sediment, bottled, and pasteurized at 165° F. for thirty minutes.

4. *Grape Fruit Juices.*—This juice is produced in Florida successfully. The juice should be extracted in such a way that the oil from the skins is excluded and an excess of bitterness from the white rag portion of the skin avoided. This can be done by cutting the fruit in half and extracting the juice on suitably constructed revolving cones. (The name of the manufacturer of the revolving cones will be sent by the writer on request.)

Grape fruit juice darkens in the bottle unless air is excluded. This can best be done, as United States Department of Agriculture investigators have found, by heating the juice to 165° F. to 170° F. in an open aluminum vessel and filling the bottles immediately with the hot juice. The bottles are filled to overflowing and capped at once. Thus all air is excluded. The bottled juice is placed in water at 165° F. and held there for thirty minutes to sterilize.

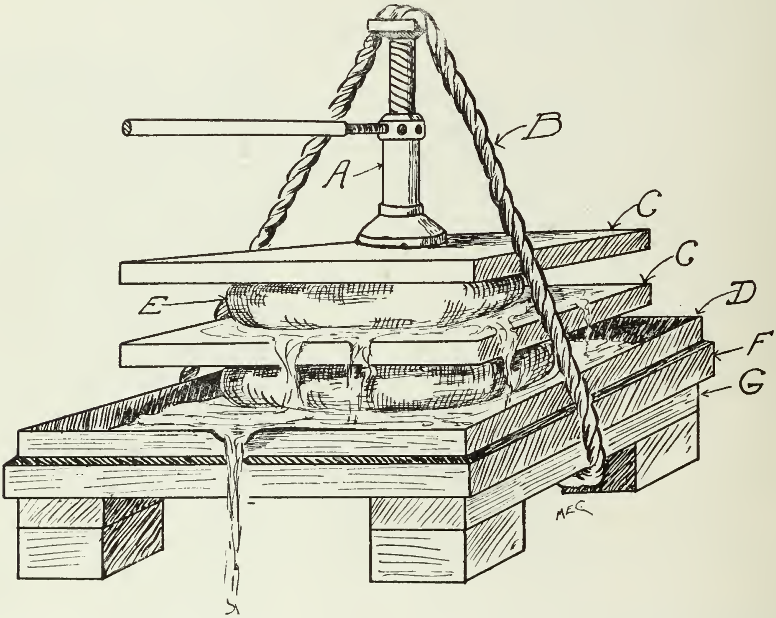

Fig. 18. Home made fruit juice press. Also suitable for pressing olives for oil. *A*, heavy wagon or automobile jack; *B*, light steel cable or one-inch rope; *C*, two pieces 2″ × 24″ × 24″; *D*, tin-lined sheet metal pan, 30″ × 30″ × 3″ with juice spout as shown, or wooden trough of same dimensions; *E*, heavy burlap to hold fruit; *F*, three inch or two inch floor; *G*, frame of 2″ × 6″ pine.

Ten per cent to fifteen per cent of sugar (¾ to 1¼ pounds of sugar per gallon) added to the juice before bottling improves its flavor. The juice is popular as a "before breakfast" appetizer and would seem to have considerable commercial possibilities.